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Research Article

The role of organic constituents of *Avicennia* in animal nutrition

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Abstract

The species diversity of mangroves of Maharashtra in general and Malvan Tahsil in particular is great. Twenty eight species have been recorded from Maharashtra. Out of these three species belonging to the genus *Avicennia* are widely used for fodder. In Malvan area of Konkan region there is scarcity of green fodder to the cattle in summer. Hence for the partial fulfillment or as a total substitute *Avicennia* is used to feed the cattle. The leaves of different species have different nutritional characteristics. Therefore, the species of *Avicennia* are analyzed for their organic chemical composition. The organic components of the plants are important to determine fodder status. The organic constituents are chlorophylls, proteins, total nitrogen, carbohydrates and polyphenols. These components have greater significance in the fodder value of the mangrove species studied, because these plants are not universal fodder species. In short it can be said that *Avicennia* species is the most preferred and hence must suffered species. The fodder value of *Avicennia is* very high. The present study indicates that the mangrove fodder is chosen because of its nutritive quality and not as the last alternative

INTRODUCTION

The species diversity of mangroves of Maharashtra in general and Malvan Tahsil in particular, is great. Twenty eight species have been recorded from Maharashtra. Out of these three species belonging to the genus *Avicennia* are widely used for fodder. All the three species are common in occurrence.

In Malvan area of Konkan region there is scarcity of green fodder to the cattle. It is more so in summer. Hence for the partial fulfillment or as a total substitute *Avicennia* is used to feed the cattle. In Kutch the mangrove fodder remained entire diet of camel (Untawale, 1985). Mangrove fodder is also used for goats, sheep and other milching animals. In dense mangrove forest of India, such as Sundarbans and Andaman-Nicobar islands the animals including deer feed upon *Avicennia* sp., *Heretiera fomes* and Nypa *fruticans* (Untawale, 1985; Naskar and Guha Bakshi, 1987; Vannucci, 1989). In Malvan area it is observed that buffalos are let free in mangrove which feed on, even the tender shoot of *Acanthus ilicifolius*. This exercise is worth watching.

Feeding of livestock during scarcity period is important, considering the pattern of Indian agriculture and livestock production. The buffalo is the main producer of milk, and will long continue to support the diary industry. An attempt is made to improve milk trait in buffalos, which requires good, adequate and well balanced rations. Feed efficiency will depend upon inputs in terms of nutrients available through different dietary ingredients.

Dairy animals obtain their food only from plants which very variable in the proximate composition. Green plants usually have more than 20 percent crude fiber (fodders), whereas, the seeds have less than 10 percent (concentrates). Chemically food is composed of water, proteins, fats, sugar (carbohydrates), minerals and vitamins. Ranjhan and Khera (1976) reported that feed of the cattle may be classified into three heads *viz.*, unconventional concentrates, unconventional roughes and industrial bi-products. These three classes of feed supply the required nutrients to the animals for better growth and yield of milk. The unconventional roughages include the tree leaves, shrubs, weeds and grasses. The leaves of different species have different nutritional characteristics. Therefore, the species of *Avicennia* are analyzed for their organic chemical composition.

MATERIALS AND METHODS

The samples were collected from Kolamb, Tarkarli and Achara estuaries of Malvan Tahsil (Sindhudurg district). The plant material was immediately sealed in air tight polythene bags and brought to the laboratory. The fresh, mature, plant leaves were randomly sampled, washed with tap water followed by distilled water and blotted dry. They were cut into small pieces, weighed accurately and used for physiological analysis.

Organic constituents like chlorophylls, carbohydrates, proteins and polyphenols were determined from fresh or dry material. Moisture contents was determined by subjecting accurately weighed fresh plant material to oven for drying at 60°C till constant weight was obtained. Chlorophylls were estimated following the method of Arnon (1949). Polyphenols were estimated by the method of Horwitz (1965). Proteins were estimated by the method of Lowry *et al.*, (1951). For all above estimations fresh samples were used. Total nitrogen was estimated following the method of Hawk *et al.*, (1948). Carbohydrates were determined from oven dry material following the method of Nelson (1944).

RESULTS AND DISCUSSIONS

In general, in the early stage of the growth, the leaves contain high percentage of crude protein and low fiber contents than the leaves of advanced age. The tree leaves are generally rich in calcium, but poor in phosphorous.

Table 1: Nutrient contents of different feeds/roughages

Sr. No. (1)	Feed Species (2)	CP (3)	EE (4)	CF (5)	NFE (6)	Ash (7)	Ca (8)	P (9)
1.	*Moringa olerifera* Lam.	15.62	2.90	17.89	48.71	11.48	1.721	0.17
2.	*Morus australis* L.	15.00	7.42	15.27	47.98	14.32	2.42	0.42
3.	*Dendrocalamus strictus* (Roxb.) Nees.	15.09	1.43	23.51	41.6	18.64	1.55	0.26
4.	*Arachis hypogea* L.	06.56	-	66.31	22.16	-	0.19	0.08
5.	*Oryza sativa* L.	06.07	-	28.00	49.98	-	0.22	0.35
6.	*Cajanus cajan* (L.) Millsp.	10.74	1.97	28.71	48.08	10.57	1.23	0.14
7.	*Avicennia officinalis* L.	12.26	0.93	11.94	56.70	18.17	0.56	0.16
8.	*Avicennia marina* (Forssk.) Vierh. **	10.80	4.18	10.04	ND	16.30	ND	ND
9.	*Ceriops decandra* (Griff.) Ding Hou **	0590	5.38	14.59	ND	10.62	ND	ND
10.	*Rhizophora mucronata* Lam. **	04.70	2.68	11.30	ND	14.00	ND	ND
11.	*Avicennia officinalis* L.*	11.60	3.60	27.70	45.70	11.20	ND	0.15
12.	*Avicennia marina* var. *acutissima* Stapf & Moldenke ex Moldenke	11.90	3.50	21.70	50.10	13.10	ND	0.18

CP - Crude Protein; EE - Ether Extract; CF - Crude Fiber; NFE - Nitrogen Free Extract
1-7 After Ranjhan and Khera (1976), 8-10 After Lawrence and Snedakar (1984)
11-12 Under Present Study

Table-1 represents nutritive values of some important species. From the table it is clear that the *A. officinalis* and *A. marina var. acutissima* are showing nutrient contents in the range of other species which are used as fodder. It is evident from the table that present values are 'higher for crude protein and crude fiber and less for ash content when compared to the earlier reports. This indicates the better status of these fodder plants. Johnstone and Hudson (1980) recorded that the dugong's diet contained mainly marine algae, mangrove leaves and to a lesser extent sea grasses, because of their energy value.

It is observed in recent years that coastal wetlands can serve as a potential pasture for production. The most desirable pasture plants in the salt marshes include *Spartina patens, Spartina cynosuroides, Spartina alterniflora, Sporobolus virginious and Distichlis spicata*. Williams (1955) reports that salt marsh pasture will support, "one animal unit", per 1.6 to 4.8 hectares depending upon the range quality. Chapman (1969) reported that domestic geese also graze the salt marshes along French channel. Along the coast of Maharashtra the species will be different than those stated above. It is found that mainly mangrove species are used for the purpose. It appears that amongst these four species, studied *Avicennia* sp. is preferred by the animals because of higher organic constituent's level which may be responsible for adding taste to the fodder.

Organic Constituents in *Avicennia*

The organic components of the plants are important to determine fodder status. The organic constituents are chlorophylls, proteins, total nitrogen, carbohydrates and polyphenols. These components have greater significance in the fodder value of the mangrove species studied, because these plants are not universal fodder species.

Chlorophylls

The higher plants traps solar energy by green leaves during photosynthesis to produce starch, the main source of metabolic energy. The photosynthetic process of the plant is dependent upon chlorophylls as antenna molecules.

Table 2: Moisture, organic matter and ash percentage of *Avicennia* sps.

Sr. No.	Name of the species	Moisture	Organic Matter	Ash*
1	*Avicennia officinalis* L.	40.20	59.80	12.30
2	*Avicennia marina var. acutissima*	38.00	62.00	13.00
3	*Avicennia marina var. resinifera* *Avicennia officinalis*	39.65	60.35	09.80
4	*Avicennia sps.*	36.62	63.38	17.00

*Values based on dry weight basis

Table-3: Chlorophyll contents from different species of *Avicennia.*

Sr. No.	Name of the species	Chl. a	Chl. b	Chl.(a + b)	Chl. a / Chl. b
1	*Avicennia officinalis* L.	58.66	17.82	76.48	3.29
2	*Avicennia marina var. acutissima*	37.67	12.04	49.71	3.13
3	*Avicennia marina var. resinifera*	53.85	17.40	71.25	3.13
4.	*Avicennia sps.*	34.80	30.84	65.64	1.13

Values expressed as mg/100 g of fresh tissue

Table-3 represents chlorophyll contents of different species of *Avicennia*. It is observed that *A. officinalis* shows highest chlorophyll contents. The values of chlorophylls differ and range from 49.71 to 76.48 mg/100 g of fresh tissue for different species. The ratio of chl. a /chl. b does not vary significantly in first three species. Kotmire and Bhosale (1980) reported-that *A. marina* var. *acutissima* shows highest chlorophyll contents, our values indicate higher levels in var. *resinifera* (Table- 3). But this has the influence of the season and environmental change. It has to be mentioned here that all the species selected for present investigation grow in close vicinity.

A. marina var. acutissima shows greater resemblance with *A. marina var. resinifera* with respect to morphology, but these two plants show a major difference with respect to chlorophylls. Sathe *et al.*, (1986) reported that chlorophyll contents of *A. officinalis* differ from place to place and is dependent on the levels of internal salts.

Table 4: Protein and total nitrogen contents in different species of *Avicennia*.

Sr. No.	Name of the species	*Proteins	**Total Nitrogen
1	*Avicennia officinalis*	1.42	2.617
2	*Avicennia marina var. acutissima*	1.47	3.050
3	*Avicennia marina var. resinifera*	1.40	3.917

*Values expressed as g/100 g of fresh tissue, **Values expressed as g/100 g of dry tissue

Table 5: Nitrogen content in leaf pairs of different age of *Avicennia* species.

Sr. No.	Name of the species	Leaf pair from Apex		
		1	2	3
1	*Avicennia officinalis*	0.24	0.26	0.38
2	*Avicennia marina var. acutissima*	0.25	0.29	0.37
3	*Avicennia marina var. resinifera*	0.18	0.15	0.31
4.	*Avicennia sps.*	0.24	0.27	0.44

Values expressed as g/100 g of fresh tissue

Table 6: Carbohydrate contents of different *Avicennia* sps.

Sr. No.	Name of the species	RS	TS	POLY	TC	Carbohydrate % Nutritive Value
1	*Avicennia officinalis*	1.82	3.40	10.65	15.87	73.
2	*Avicennia marina var. acutissima*	0.36	1.60	16.28	18.24	71.5
3	*Avicennia marina var. resinifera*	0.54	1.60	16.28	46.98	ND

Values expressed as g/100 g of dry tissue.

Table 7: Polyphenolic contents of different *Avicennia* sps.

Sr. No.	Name of the species	Polyphenols
1	*Avicennia officinalis*	1.42
2	*Avicennia marina var. acutissima*	2.50
3	*Avicennia marina var. resinifera*	1.70
4.	*Avicennia sps.*	0.88

Values expressed as g/100 g of fresh tissue.

Proteins and Nitrogen

The proteins are complex organic compounds of high molecular weight which are involved to make up different tissues and organs in the body. The approximate composition of proteins is nitrogen (16%), carbon (52.5%), hydrogen (7%) and oxygen (21%) with remaining traces of sulphur, phosphorus and iron. Since the nitrogen content in the pattern is about 16 percent, it is analyzed in the feedstuffs by Kjeldahl's method and multiplied by the factor 6.25 to get the protein in storage plants. However, this factor differs in different plants.

The proteins are major components of blood, muscles, and connective tissues in animals. When protein is fed in excess it serves as a source of energy and fat. The protein contents of different species of *Avicennia* are shown in Table- 4. The crude protein .percentage is about 12 in two species of *Avicennia* (Table.1). The saline extractable protein is also nearby the same (Table-4.5). However, there is great difference in nitrogen contents.

Nitrogen is an important constituent of amino acids, proteins and nucleic acids. The non protein compounds like amides, nitrogenous glycosides, alkaloids, ammonium salts, nitrates etc. contains nitrogen as important ingredients. The total nitrogen contents of the four species studied, in the present investigation (Table 5) shows great variation. The nitrogen contents in

A. marina var. resinifera is higher than other species. Our values mentioned in the table are on the similar line with earlier reports (Bhosale, 1974; Kotmire and Bhosale, 1980). Nitrogen content is low in summer. The proteins also vary seasonally and generally increase from winter to monsoon in *Sonneratia* species (Telave, 2005).

Carbohydrates

Table records carbohydrates estimated by the method of Nelson (1944). The values depicted in the Table- 6 show higher carbohydrates in *A. marina var. acutissima*, than other species. The levels of carbohydrates in *variety resinifera* are intermediate to other two species. Our values are on similar lines of the reports of Kotmire and Bhosale (1980).

In general mangrove leaves contain higher levels of carbohydrates as compared to other glycophytes (Chirputkar, 1969; Bhosale, 1974 and Bhosale *et al.*, 1983). Telave (2005) has studied biochemical status of *Sonneratia* Species. He has explained the role of starch, total soluble sugars and reducing sugars in nutrition. This parameter adds to the fodder value of the plants. Nevertheless, a negative feature is polyphenol (tannin) contents. Therefore, present study is extended to polyphenol estimation.

Polyphenols

It is reported that because of polyphenols digestibility of proteins in the leaves becomes low (Arora, 1988). The polyphenols are secondary metabolic products in higher plants. The mangroves are rich in polyphenols. Humhpries (1967) has reported polyphenol contents up to 35% and stated that mangroves in spite of more salt concentration contain large amount of water soluble tannins. Jamale and Joshi (1976) showed that the amount of polyphenols in the leaves of mangroves is dependent upon the age of the leaves and polyphenol degrading enzymes.

Table- 7 represents the polyphenolic contents of the leaves from four *Avicennia* species. Karkar and Bhosale (1986) reported that *R. apiculata* leaves show more polyphenols than *K. candel*. Kotmire and Bhosale (1980) reported that *A. officinalis* shows more polyphenols than *A. marina* var. *acutissima* leaves. In the present work similar trend is noted.

On this basis of field observations it can be said that *Avicenni*a sp. (which is sometimes mistaken for *A. alba*) is the most suffered species. This is supported by the polyphenolic contents where the lowest level is found in this species. It is also observed that whenever *A. officinalis* is available it is preferred over *A. marina*. This observation also goes hand in hand with polyphenol levels in the leaves. In short it can be said that *Avicennia* species is the most preferred and hence must suffered species.

Thus, the fodder value of *Avicennia is* very high. Malik *et al.,* (1986) have recorded that in Pakistan the best type of fodder available, are alfa-alfa, clover, barley, cabbage beet root, sunflower and mangroves. In this list mangroves proved to be superior. *Rhizophora mucronata*, *Ceriops decandra* are equivalent to the average quality fodder such as- millets, sorghum, oats and sugarcane leaves (Hamilton and Snedaker, 1984).

According to Morton (1965) when milk cows are fed on *R. mangle*, milk yield increases. In the present study similar information was received for the mangrove fodder users with respect to *Avicennia*, which is locally known as, "Tivar". Feeding trials on sheep with *Avicennia* species in Madras have shown promising results (Kurian and Patodia, 1980). Even the poultry feed made from mangrove leaves and twigs is very nutritious and comparable with high quality present day feed (Allen, 1981). As back as, 1950 the trial was made with poultry and weight of the chicks was found increased (Sokoloff *et al.*, 1950). Chapman (1976) has also mentioned the leaves of *Sonneratia alba* and *Sonneratia caesolaris* are used as fodder.

Untawale *et al.*, (1978) studied seasonal changes in nitrogen, carbohydrates, lipids and organic carbon of mangrove foliage.

The carbohydrate and protein shows significant variation in *Brugueria parviflora. Avicennia officinalis* has shown maximum lipids in summer. Banerjee *et al.,* (1998) have reported that estuarine grass *Aeluropus lagopoides* and mangrove associate *Derris heterophylla* is used as fodder by animals along the Godavari-Krishna delta of Andhra Pradesh.

Alhadranim *et al.,* (2002) qualitatively and quantitatively determined chemical constituents of *Avicennia marina and Atriplex canescence* for nutritional status for camels. They have reported that crude protein in the leaves of two plants were similar (10.6-10.7 %). The values for both the species of crude fiber, cellulose and lignin are 18-18.9%, 17.8-18.8% and 4.1-4.8% respectively. Thus, these two species are used as fodder by desert camels in Arab Gulf Countries.

Upadhyay *et al.,* (2002) reported that mangroves are highly useful to mankind. They are useful as a source of fuel, furniture from wood while green leaves and fruits for fodder to the cattle's. The foliage of many mangrove species is used as fodder for cattle's, camels and goats. *Avicennia* is largely used as fodder for camels and other cattle as it grows in arid region of Gujarat as well as Konkan and Goa (ENVIS, 1988). Kumar (2004) has stated that *Rhizophora apiculata* is being used as fodder along Goa coast. Similar type of observation has been recorded along the Konkan region of Maharashtra by Bhosale (2005).

Report of FAO (2012) stated that mangroves are extensively used as camel fodder throughout the northeast Africa, the Middle East and in Pakistan. In Egypt *Avicennia marina* leaves are used by camels and goats for browsing particularly in times of drought.

It has reported that five thousand camels graze on mangrove islands of Indus-Delta. In this area *Avicennia marina* has suffered a lot due to over grazing. The present study indicates that the mangrove fodder is chosen because of its nutritive quality and not as the last alternative.

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